

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

1. (Currently amended) A method of evaluating tolerances of computer assisted designs for the manufacture of objects comprising, for each object:

representing each tolerance zone for each geometric feature of said object by a model with an algebraic form and a geometric form, wherein the geometric form is represented as a tolerance map stored in a computer, each tolerance map comprising a hypothetical space of points that describes the acceptable positions of a surface of the object, wherein the tolerance map is a mapping of physical space into the hypothetical space of points such that the shape and size of the hypothetical space of points are functions of the tolerance zone;

computing in said computer interdependencies between said stored maps and interdependencies between submaps of said stored maps to determine how different tolerance zones for said geometric feature affect each other and to determine how different tolerance zones for different geometric features of said object affect each other, wherein a tolerance zone includes subzones and submaps correspond to subzones of tolerance zones;

determining how different tolerance zones for geometric features on different objects affect each other; and

selecting tolerance conditions for said object to optimize allocation of tolerances to each of said geometric features of said object or objects.

2. (Previously presented) The method of claim 1 where representing each tolerance zone for each geometric feature of said object comprises creating a tolerance map in three dimensions representing a plane.

3. (Previously presented) The method of claim 1 where representing each tolerance zone for each geometric feature of said object further comprises creating a tolerance map in four dimensions representing a line, axis or edge.

4. (Previously presented) The method of claim 1 where representing each tolerance zone for each geometric feature of said object further comprises creating a tolerance map in five dimensions representing the tolerances for each cylindrical surface, including tolerance on size and the tolerance-zone for the position of the axis of the cylindrical surface.

5. (Previously presented) The method of claim 1 where representing each tolerance zone for each geometric feature of said object comprises creating a tolerance map representing a position.

6. (Previously presented) The method of claim 1 where representing each tolerance zone for each geometric feature of said object or objects, comprises a tolerance map representing composite tolerances constructed as a Minkowski sum.

7. (Currently amended) The method of claim 1 where representing each tolerance zone for each geometric feature of said object comprises a tolerance map in a space of points of variational possibilities of features of said object, and the tolerance map represents a population of imperfections in the object.

8. (Previously presented) The method of claim 1 where representing each tolerance zone for each geometric feature, or combination of geometric features, of said object comprises creating a tolerance map in a space of points that represent the variational possibilities of manufacture for the features of said object.

9. (Previously presented) The method of claim 1 where representing each tolerance zone for each geometric feature, or cluster of geometric features, of said object comprises creating a tolerance map in a space of points that represent the variational possibilities of manufacture for the features of said object expressed in areal (barycentric) coordinates.

10. (Previously presented) The method of claim 1 where computing in said computer interdependencies between said stored maps and interdependencies between submaps of said stored maps comprises superimposing on a tolerance zone of said geometric feature an orientation tolerance zone which more stringently controls the orientational variations including parallelism, angularity and perpendicularity, from the nominal condition of said geometric feature.

11. (Previously presented) The method of claim 1 where computing in said computer interdependencies between said stored maps and interdependencies between submaps of said stored maps comprises superimposing on a tolerance zone of said geometric feature a tolerance zone specifying form including flatness, straightness and cylindricity of said geometric feature.

12. (Original) The method of claim 1 where computing in said computer interdependencies between said stored maps and interdependencies between submaps of said stored maps comprises generating a tolerance zone of an assembled geometric feature for a assembly of at least two objects, each of which objects has a corresponding tolerance zone for corresponding geometric features which are being assembled to comprise said assembled geometric feature.

Claims 13-15 (Canceled).

16. (Original) The method of claim 1 further comprising establishing a global model by mapping surfaces used as datum or targets in a dimensioning scheme to equivalent control frames in which datum reference frames are rigid sets and validated using degree of freedom algebraic operations, and by representing dimensions and tolerances by the union of corresponding control frames involving the datum and target rigid sets and corresponding tolerance classes.

17. (Original) The method of claim 16 wherein mapping surfaces used as datum or targets in a dimensioning scheme to equivalent control frames comprises forming datum reference frames as rigid sets for target features and feature patterns.

18. (Original) The method of claim 17 wherein mapping surfaces used as datum or targets in a dimensioning scheme to equivalent control frames in which datum reference frames are formed as rigid sets for a circular pattern of bolt holes.

19. (Original) The method of claim 16 further comprising identifying redundant or conflicting restraints by using a degree of freedom algebra on control frames by determining whether the corresponding datum reference frame is a rigid set and the maximum degrees of freedom which said datum reference frame controls.

Claim 20 (Canceled).

21. (Previously presented) The method of claim 1 where representing each tolerance for each geometric feature further includes representing tolerances for each tab or slot feature by generating a tolerance map in four dimensions that represents each feature, including the tolerance on feature size and the tolerance-zone for feature mid-plane.

22. (Previously presented) The method of claim 1 further including representing a symmetry tolerance zone for features including a tab, slot, or cylinder,

having two tolerances on size and the symmetry for relative position of feature mid-planes and/or axes, by creating a tolerance map in five dimensions to represent the symmetry of the tab or slot feature, or in six dimensions to represent the symmetry of the cylinder feature.

23. (Previously presented) The method of claim 1 where further including representing the tolerances for a cluster of features including a point and a line, or a plane and a line, by creating a tolerance map of a dimension higher than the dimensions of a tolerance map for either feature individually, but lower than the sum of the individual dimensions of a tolerance map for either feature.

24. (Previously presented) An apparatus for analyzing geometric variations (tolerances) to integrate parametric CAD with tolerance analysis and optimization of a manufactured object comprising a computer wherein is stored:

- a geometry engine module E1 to generate a B-rep solid model of said object;
- a constraint solver E2 to generate a D&T graph of said object;
- a geometry definition system M1 communicated to said geometry engine module E1 and constraint solver E2;
- a dimensioning module M2 for receiving said B-rep solid model and said D&T graph as input data;
- a tolerancing module M4 communicating with said dimensioning module M2;
- a global visualization module M3 communicating with said tolerancing module M4;

a D&T Schema Advisor module M5 communicating with said tolerancing module M4;

a tolerance allocation module M6 communicating with said tolerancing module M4;

a local model visualization module M7 communicating with said tolerance allocation module M6 for providing a geometric visualization of tolerancing of said object; and

a statistical tolerance analysis package E3 communicating with said tolerance allocation module M6 for providing an algebraic visualization of tolerancing of said object.

25. (Previously presented) The method of claim 1 where representing each tolerance zone for each geometric feature of said object comprises creating combinations of said maps to represent the interaction between tolerances applied to each geometric feature.

26. (Previously presented) The method of claim 1 where representing each tolerance zone for each geometric feature of each object comprises creating combinations of said maps to represent the accumulation of tolerances in the geometric features of the objects in stack-up analysis.

27. (Previously presented) The method of claim 16 further comprising validating if the proper degrees of freedom of a feature are controlled by a datum

reference frame, by using the global model to analyze the degrees of freedom controlled progressively to determine which degrees of freedom are controlled collectively by all datums in the datum reference frame and to determine which individual datum controls each degree of freedom to analyze the effect of datum precedence.

28. (Previously presented) The method of claim 16 further comprising using the global model for tolerance refinement by controlling the same degree of freedom by more than one degree of freedom for selective finer controls on certain degrees of freedom.